FACULTY SUPPORT FOR THE OBJECTIVES OF UNIVERSITY-INDUSTRY RELATIONS VERSUS DEGREE OF R&D COOPERATION: THE IMPORTANCE OF REGIONAL ABSORPTIVE CAPACITY

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This version: 07/06/2005

Abstract

The growing importance of regions in the analysis of innovation and the pressure on European universities to interact with their environment justify this article. It argues that faculty support for the objectives of university-industry relations (UIR) does not vary across disciplines and does not respond to university encouragement in a region with low absorptive capacity. These results are in contrast with those obtained in studies of technology leading countries like the USA. Furthermore, incentives for UIR may generate unpredicted dynamics while instruments to cooperate are not significant. Finally, support for the objectives of UIR should not be confused with the degree of R&D cooperation. The former is sensitive to university age while the latter is sensitive to gender, discipline, commitment to R&D and university encouragement. Empirical evidence is obtained from a sample of faculty from the Valencian Community (Spain) and analysed through a set of models for discrete choice.

Keywords: university-industry relations, absorptive capacity

JEL - codes: O31 - Innovation and Invention: Processes and Incentives, C25 - Discrete Regression and Qualitative Choice Models

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Earlier versions of this paper were presented at the Druid Summer Conference 2003 and the 10th Seminar Altec 2003.

1. Introduction

When universities incorporated research among their functions in the 19th century, they received strong support from industry (Etzkowitz and Leydesdorff, 2000). After World War II, the consideration of basic research as the engine of development (Bush, 1945) and the fear that an excessive interference in the agendas of academic researchers would deteriorate the quality of that research (Merton, 1942) caused the share of industry funding to decline during the 1950s and the 1960s (Mowery et al., 2001). Among other reasons, the economic crisis of the 1970s and a better understanding of the complex link between industrial innovations and scientific activities (Kline and Rosenberg, 1986) are behind the calls for a more active role of the university in society. Coincident with a surge of commercialisation of science-based technologies, like biotechnology and information and communication technologies, seen as examples of successful science because of their tangible results, the belief that such an active role must rely on increased links between university and industry grew. This period in the USA witnesses the promotion of university-industry links through policy initiatives that also try to stimulate the development of tangible results as a merit in researchers' curricula. Most developed economies in Europe follow this example (Geuna, 1999, Martin, 2003).

Within innovation studies, several approaches have come to justify the interweaving of universities in the economy: Freeman (1987) and Lundvall (1988) under the perspective of national systems of innovation, Gibbons et al. (1994) with their detection of new Mode 2 of knowledge production, Etzkowitz and Leydesdorff (1996) with their ideas about the Triple Helix model, etc. These approaches differ in the importance granted to universities in the innovation process, but do not question that some degree of interaction with firms should exist.

Other voices have been more critical. The economics of science approach recovers the Mertonian ideas that the mechanism of review by peers can efficiently assign R&D resources (Dasgupta and David, 1994). It also emphasises that the promotion of university-industry relations (UIR) responds to a narrow vision of the benefits of basic research, which leaves aside less tangible but equally beneficial links with innovation (David et al., 1994). Some of these benefits are increasing useful knowledge, training skilled graduates, creating new scientific instrumentation and methodology, forming networks and social interaction, increasing the capacity for scientific and technological problem-solving, creating new firms (Salter and Martin, 2001), providing social knowledge and access to unique facilities (Scott et al., 2002).

In this context of opposite opinions on the benefits of UIR, our target questions are what determines support for its objectives and whether this support is sufficient for some degree of cooperation to take place. In addition, our research asks whether the answer to these questions is likely to be the same in technology-leading countries like the USA or Germany and in a region with low absorptive capacity[1]. Cultural, socio-political and economic differences of European regions have placed the emphasis of European innovation studies on regions rather than nations as a unit of observation. On the other hand, the pressure on universities to interact with industry is still an issue in vigour in Europe, where each region searches its own way to involve universities into regional development (Chatterton and Goddard, 2001).

In order to reach our objectives, the paper has the following structure: Section 2 details the state-of-the-art on these debates and specifies our research hypotheses. Section 3 provides an example of a European region with low absorptive capacity, the Valencian Community, which will be the context of our research for testing the hypotheses. Section 4 explains the methodology to test them and the data to use. Section 5 shows the results of the econometric estimations on the data. Finally, section 6 concludes and suggests lines of future research.

2. Faculty support for university-industry relations versus R&D cooperation

According to our target questions, we divide the following literature review into the two main aspects to tackle: first, what determines support for the objectives of UIR; second, whether support for the objectives of UIR is sufficient for some degree of cooperation to take place. In each sub-section, we derive hypotheses to be tested within a regional context.

2.1. Support for the objectives of university-industry relations

We subdivide existing studies into two groups: those that have already econometrically tested some hypotheses within a national context, and those that allow us to expand the theoretical base in order to justify new hypotheses. The next sub-sections cover one group each.

[1] We follow Cohen and Levinthal's (1990) definition of absorptive capacity: "a limit to the rate or quantity of scientific or technological information that firm can absorb". To justify the extension of the concept of absorptive capacity from firms to regions, see Niosi and Bellon (2002).

2.1.1. The determinants of support at national level: valid in a region with low absorptive capacity?

To our knowledge, the most systematic attempt to study faculty views about the objectives of UIR is the one by Lee (1996), who in 1994 carried out a survey of around 1000 faculty members in 115 American universities. One of the questions dealt with their support for seven objectives of UIR. These were:

- To favour oriented research in the university.
- To promote patentable inventions.
- To participate in regional economic development.
- To intensify the commercialisation of the results of academic research.
- To stimulate the activities of faculty consulting for industry.
- To offer aid for the start-up of new technology-based firms.
- To stimulate equity investment in firms based on academic research.

The results showed that a majority of the respondents supported the first five objectives and that a majority rejected the last two. The author attributed this to the fact that the first five represent a pragmatic form of adaptation to the new tendencies in transmission of knowledge, whereas the last two imply an excessively close commercial relationship with private industry, which, among other things, increases the time dedicated to management and decreases the time dedicated to basic research.[2]

Lee explored the distribution of support for the objectives of UIR according to diverse variables using Pearson tests to justify the significance of the differences. He found some evidence of a negative relation between university prestige and UIR. However, age is a factor underlying scientific prestige, as it can be argued that prestige is cumulative at institutional level. Consequently, older universities may tend to have higher scientific prestige. It can also be argued that age is a factor underlying cultural roots that impose resistance to change. Especially in Europe, where the Humboldt model of Research University is predominant, the recent surge of UIR may make historical universities more reluctant to incorporate them as part of their mission (Clark, 1998). Therefore, we would derive the following hypothesis:

H1: The older the university, the less will be its support for the objectives of UIR.

Lee also found support for the following hypotheses (the formulation is ours, not Lee's):

H2: Faculty in engineering and technology will show higher support for the objectives of UIR.

H3: The higher dedication to R&D activities, the higher the support for the objectives of UIR will be.

H4: The higher perceived university encouragement, the higher the support for the objectives of UIR will be.

H5: The higher the fears to the effects that UIR could cause on academic life (e.g. to affect academic freedom, to press for short-term research, to affect long-term research and to cause conflict of interests), the less the support for the objectives of UIR will be.

The author made an econometric estimation to explain two objectives –favouring oriented research and commercialisation of the results of academic research, and he extended the conclusions to the rest of the objectives. He did not test H1, but the rest. He measured "dedication to R&D activities" through the amount of R&D funds and he found no additional support for H3. He did find it for hypotheses 2, 4 and 5. In H5, he just included one fear, the possible loss of academic freedom. He placed special emphasis on this last result, since he recommended, first, the reversal of the decline of federal support for basic research in the USA, which increases the fear of UIR and therefore diminishes its support, and secondly, the necessity of a better understanding of the justification of that fear.

There has been no equivalent effort to Lee's in the case of European catching-up countries, such as Italy or Spain (European Commission, 2001), where Geuna (1999: p. 173) thinks that there may be a greater margin for the development of UIR before it gives rise to unexpected consequences. One of the main features of most regions in these countries is their low absorptive capacity. In these conditions, firms in these regions will be less likely to adopt university research, which may change the behaviour of academics regarding support for relations with industry. A sample of one of these regions is therefore needed to validate Lee's results.

2.1.2. Further determinants of the support: the role of personal characteristics, incentives and instruments

The literature has long studied the idea that some personal characteristics matter in the process of scientific production. Stephan (1996) sums up some findings about the influence of age, e.g. age is inversely related to research productivity and the acceptance of new ideas, but weakly. Kotrlick et al. (2002) find from their bibliographical review evidence that the relation between age and research productivity, if any, is negative, but results are not conclusive and their own finding is that it is not determinant. However, since individual research productivity has cumulative features (Merton, 1968), we believe that a better explanatory factor than age could be a measure taking into account other features of seniority, e.g. teaching rank, research awards, etc.

Regarding gender, Kotrlick et al. (2002) reach similar conclusions as with age. Traditional evidence points to higher research productivity in male faculty, but not conclusively. Xie and Shauman (1998) find that with

[2] For equity investment, the author also recommended the public sector to cover the gap left by universities.

enough control variables (time between a bachelor's degree and a PhD, marital status, time in classroom teaching, likelihood of securing research funding and research assistance) differences in research productivity disappear.

Both seniority and gender may be related to support for UIR. In addition, two other personal characteristics may deserve some attention. These are holding a managerial position, and having done research abroad. Let us assume that if most faculty support UIR, they will choose managers who lead them to that goal. Let us also assume that faculty who do research abroad do so to improve their scientific knowledge. Hence, they will tend to travel to leading scientific countries with more to offer, especially if they are from regions with low absorptive capacity. Some of these leading countries also interact more with industry (e.g. the USA). Therefore, faculty who do research abroad may come into contact with a more interactive culture.

All these considerations allow us to formulate the following compound hypothesis:

H6: Senior, male faculty, who hold a managerial position and have done research abroad for longer periods will show higher propensity to support the objectives of UIR.

Apart from personal characteristics, since Lee (1996) included the fear of the disadvantages of UIR among the determinants of the support for its objectives, we should include the other face of UIR, the incentive to benefit from its advantages. Meyer-Krahmer and Schmoch (1998) provide a list of such advantages, e.g. additional funds, knowledge exchange, etc. They made a survey in 1997 of 433 German professors who ranked those two advantages first. Our hypothesis is:

H7: The more positive the perceived influence of UIR on some faculty incentives, the higher the support for the objectives of UIR will be.

If we did not find evidence in favour of this hypothesis, we could question not the proposition but its instrumentation. In other words, once we consider the incentives to interact as possible determinants of the support of UIR, we may enter the debate as to whether incentives matter more than opportunities and, in the case of UIR, opportunities take the form of instruments that faculty are allowed to use in order to cooperate. Meyer-Krahmer and Schmoch (1998) provide a list of such instruments, although they call them "types of interactions": collaborative research, informal contacts, education of personnel, contract research, consultancy, etc. Hence, we may propose this hypothesis:

H8: The existence of instruments of cooperation will increase the propensity to support the objectives of UIR.

If we consider that preference for one instrument over another may entail differences in support for UIR, we can refine the previous hypothesis as follows:

H8a: The greater the preference for one instrument of cooperation, the higher the propensity to support the objectives of UIR will be.

Meyer-Krahmer and Schmoch (1998) found that collaborative research and informal contacts were ranked higher than contract research and consultancy. This, together with the high ranking of knowledge exchange as an incentive, led them to interpret their findings as a sign of preference for two-way as against one-way flows in UIR. This allows us to refine H8 thus:

H8b: The more bidirectional an instrument of cooperation, the higher the propensity to support the objectives of UIR will be.

2.2. Degree of R&D cooperation: same as support for the objectives of UIR?

Lee (1996) implicitly assumes that support for the objectives of UIR is a necessary condition to achieve some degree of UIR. He does not address the question of whether it is a sufficient condition. We consider it of interest to provide a theoretical framework that admits that the two phenomena may follow different processes. The reason is that while support encompasses purpose, R&D cooperation requires actual action. The coincidence between individuals that declare some intentions and individuals that go ahead with action should not go unquestioned. For this reason we propose the following hypothesis:

H9: The determinants of R&D cooperation are coincident with those of the support for the objectives of UIR.

Evidence against this hypothesis may mean that faculty who support the objectives of UIR are not the same as those who perform R&D cooperation, so it is crucial for policy initiatives.

How to measure R&D cooperation is certainly difficult. Many studies have focused on technology transfer indicators, e.g. industrial funding of university R&D, disclosures, patents and licenses, etc. (see Bozeman, 2000 for a review, or empirical studies by Rogers et al., 2000 and Thursby and Kemp, 2002). In the terms of Meyer-Krahmer and Schmoch (1998), they indicate unidirectional rather than bidirectional flows.

Schartinger et al. (2002) provide an econometric explanation of the determinants of a more bidirectional measure of R&D cooperation, since their dependent variable is the number of what they call “knowledge interactions”, namely the use of certain instruments of interaction (joint research, contract research, personnel mobility and training and lectures). However, the unit of observation is not individual faculty members, as in Lee (1996), but the interaction between field of science and economic activity, so logically the explanatory variables also differ and consequently it is difficult to compare the results with the support for the objectives of UIR. An exception may be the inclusion of disciplinary dummies, where they find that natural, technical, agricultural and

economic sciences have a significantly higher propensity to interact than medicine, social sciences and humanities in the Austrian case. This contrasts with Lee's finding that technical sciences are the only ones to stand out in support for UIR. Nevertheless, the different sample and construction of dummies do not make comparison straightforward.

In order to find a suitable measure of R&D cooperation for our purpose, we propose a subjective approach where faculty members self-asses their degree of R&D cooperation with industry. This has two main advantages. First, it allows faculty to include some bidirectional aspects of this cooperation, e.g. the perception of their degree of collaborative research or informal contacts that would not fit into usual technology transfer indicators (industrial funding, patents, etc.) Second, it focuses on individual faculty members as the unit of observation, thus making comparison with the support for the objectives of UIR possible.

Non-econometric literature has explored many of the relations between the explanatory variables presented in section 2.1 and R&D cooperation, but it is beyond the scope of this review to present them one by one. Let us focus on the equivalent of H8 in the context of R&D cooperation (*the existence of instruments of cooperation will increase the propensity to cooperate in R&D*). It is of particular interest since some authors have challenged it on several occasions. For instance, Mahdi and Pavitt (1997) and Koumpis and Pavitt (1999) find that increasing R&D cooperation in speech recognition and computational chemistry is a spontaneous phenomenon arising from technological opportunities.

Besides, at least regarding instruments that entail formalisation of relations, Faulkner and Senker (1995) have shown how the noticeable emphasis on formal projects does not imply that the informal collaborations are not important, and that the former only represent the tip of the iceberg. Better than considering formal and informal relations as substitutes, we should understand that informal relations usually precede or initiate formal projects. For the authors, formal and informal contacts in the form of consultancy, funds, and exchange of ideas, practices and research results mediate the relation between universities and firms.

In this sense, through interviews with a series of spin-off firms in technology leading sectors, Rappert et al. (1999) find that these firms think that universities lack entrepreneurial abilities, that they organize their work in a way which is difficult to manage, and that they are not interested in developing technology or in properly evaluating it. Nevertheless, firms appreciate that changes are taking place in the universities and that they are adopting a more contractual and commercial orientation. Informal links do not seem to be affected by this because firms that maintained them before continue to maintain them, although they sometimes notice that faculty negotiate in market terms that they do not master, because "the desire for universities to be more

commercially relevant then does not necessarily equate with them being commercial per se" (op. cit., p. 882). On the other hand, firms notice that formal links deteriorate because faculty overestimate their industrial property[3] and contractual agreements in this matter can be very difficult.

Since informal links entail a greater degree of bidirectional flows between university and industry, these authors show implicit support for the equivalent of H8b *(the more bidirectional an instrument of cooperation, the higher the propensity to cooperate in R&D will be).*

3. The context of the research: the Valencian Community, a European region with low absorptive capacity

The Valencian Community is a Spanish autonomous region with shared competences in science and technology (S&T) policy, so the agents that constitute the regional system of innovation are subject at the same time to both national and regional policies in this field.

Since 1988, national S&T policy has taken the form of four-year National R&D Plans. The name of the currently running Fifth Plan, "R&D&I Plan", where "I" stands for "innovation", clearly reflects the intended orientation of Spanish R&D –implicit from the First Plan (1988-1991). This orientation guided the design of the Technology Transfer Office (TTO) Network and its creation in 1989, to support interchanges among universities or other public research institutions and firms. At the same time, the National Plan put in place several financial instruments to enable R&D results to be transferred to firms in the short run with a high probability of success (PETRI Program). During the successive National R&D Plans, not only has the support for the TTO Network and the PETRI Program been maintained, but also the discourse regarding the need to undertake oriented R&D in order to achieve a higher innovative performance in Spain has been intensified.

In turn, the Valencian regional policy has also agreed in the diagnosis of the need to enlarge university involvement in the socioeconomic development of the region. Real support, however, has been erratic, as has the application of policies, which have suffered may changes. Currently, a Regional R&D and Innovation Plan (2001-2006) does actually exist (Generalitat Valenciana, 2002) which foresees an increased university presence in the solving of firms' technological problems, and relies on an Innovation, Development and Transfer program, although it has not yet materialised with the support of specific instruments.

[3] In the specific case of the unsuitability of patent licensing as an instrument for promoting knowledge transfer, there is abundant literature (e.g. Henderson et al., 1998, Mowery et al., 2001, on the US case, or Azagra et al., 2003, on the case of a Valencian university).

In socioeconomic terms, 4.3 million inhabitants (10% of Spain) constitute the Valencian Community, with a GDP that in 2002 was 95% of the national average and just 66% of the European average (EC, 2003). In its economic structure, the services sector contributes 63% of the Gross Added Value, industry 24%, housing 10% and the primary sector 3% (INE, 2005a). Its business structure is mainly constituted by small firms (less than 1% of the firms have more than 50 employees, INE, 2005b) oriented towards traditional industrial sectors, such as toys, textile, shoes, furniture or ceramics. There are very few firms in knowledge intensive sectors (pharmacy, electronics, ICT, etc.), which does not contribute to the establishment of common interests between the public research system and the business sector, nor to strengthen firms' demand for university science.

In terms of technological development, according to Cohen and Levinthal (1990) and Mowery and Oxley (1995), the Valencian Community shows the features of a region with a low absorptive capacity. In fact (Table 1), regional R&D expenditure as a proportion of regional GDP in 2001 was only 73% of the national figure and 36% of the figure for the EU. This regional situation seems to be more unfavourable when R&D investment by private business sector is considered, as in this case it only represents 0.2% of regional GDP, in contrast to 0.51% for Spain as a whole and 1.3% for the EU. As regards human capital, the percentage of the region's population with higher education is two points lower than the national average; the difference doubles if we consider this group as a percentage of the employed or active population.

Five public universities with more than 8,000 professors, which taught more than 132,000 students in 2002, form the regional higher education system. 40% of these professors were involved in social sciences, 34% in engineering and technology, 11% in humanities and the remaining 15% in exact, natural and health sciences (Hernández Armenteros, 2004). As Table 2 shows, the region's public higher education system presents relative robustness. It has more than 10% of the students and professors in Spain, and its budget represents 1.2% of regional GDP, in contrast to the 0.9% of GDP for the national public university budget.

Some differences exist among the five universities within the region, regarding their age, size, subject specialization, and active participation in UIR. The oldest university (five hundred years old) is also the largest one, absorbing 37% of all the teaching staff. It mainly orients its teaching activity towards social sciences (Table 2), and has the highest scientific prestige –its share of granted funds is five points higher than the regional average (Table 3). The second oldest (forty years old) and second largest university employs 27% of the professors, its teaching activities are mainly oriented towards engineering and technology (Table 2) and it is the one with the highest reputation for active involvement in UIR –its share of contractual funds is almost double the regional average (Table 3). The three remaining universities are the youngest (created during the last twenty-five

years) and the smallest ones. Of these, two are strongly oriented towards social sciences and the other and smallest one shows a higher orientation towards engineering and technology and health sciences (Table 2), contractual funds in these universities being lower than the regional average (Table 3).

Each of these five universities has a TTO to facilitate UIR, integrated into their organisational structure. The TTOs of the three oldest universities started their activity in 1989 and those of the most recent universities in 1996 and 1997 respectively (Table 3). In one of these two cases the TTO started when the university was launched and in the other one five years later. Generally speaking, TTOs assume all management functions regarding contractual funds, although at three universities the TTO is also responsible for the management of granted funds, so we must compare their budgets with caution.

The data in Table 3 highlight the relative strength of UIR at the region's universities compared to Spain's public universities as a whole, with a higher income derived from contractual R&D, and stronger support of the regional universities for these relationships. In fact, income derived from UIR –contractual R&D– and managed by TTOs in the region in 2002 was 3.74% of the overall university budget, in contrast to the 3.24% of the Spanish universities as a whole. The average investment made by regional universities in the maintenance of these structures is 0.33% of their budget, in contrast to the Spanish average of 0.11%.

4. Methodology and data

Our intention is to estimate a series of econometric models to test the hypotheses put forward in the previous section, using as explained variables faculty support for different objectives of UIR and their degree of R&D cooperation with firms. In order to estimate the models, we have data on faculty from the Valencian Community, gathered through a survey made in 2001. We will explain first, the sample, the variables built and the techniques of estimation, then some descriptive statistics of the variables.

4.1. Sample, variables and techniques of estimation

The population of the survey is faculty from the five public universities of the Valencian Community. We stratified it in three categories: full professors, assistant professors and associate professors[4]. Selection was by means of simple random sampling. The sample was 10% of the population, or 872 individuals.

The questionnaire was sent by the research vice-rectorates of each university by electronic mail to the random sample of faculty. Once filled in, faculty members could return the questionnaire by electronic mail, ordinary mail or fax. After a first stage of spontaneous response, a follow-up team was organised to make telephone contact with the professors of the sample. This fieldwork took place between 22nd May 2001 and 30th June 2001. Finally, we obtained a response rate of 44%, so we could build a database with 382 observations.

Table 4 shows data from the survey about the change in faculty attitudes over time in the Valencian Community. The proportion of faculty favourable to university being engaged into R&D activities for industry is 94%. If we believe retrospective answers, this positive attitude was preponderant five years before the survey, but in a lesser proportion, 86%. Therefore, there seems to be a trend towards increased acceptance of university-industry interaction that deserves our attention. Lee (1996) found a similar trend comparing the 1980s and the 1990s in US, although the level of acceptance was a bit less.

The questionnaire included questions regarding the support for different objectives of UIR and the degree of R&D cooperation. In our econometric specification, they become the following dependent variables:

- Support: importance given to different objectives of UIR, ranked as follows: 0 ("no or weak support"), 1 ("some support") and 2 ("strong support"). It is a vector of six variables, one per objective:
  - Orientation: to favour oriented research in the university.
  - Development: to participate in the economic development of the region.
  - Commercialisation: to intensify the commercialisation of the results of academic research.
  - Firms: to favour the creation of firms based on academic research.
  - Funds: to obtain additional funds for R&D activities.
  - Teaching: to adapt teaching programmes.

The first four objectives are analogous to Lee's (1996), whereas the last two are new. We considered it appropriate to include them since they are explicit objectives of UIR. First, governments expect that UIR will

[4] The equivalence between the Spanish original categories and the three categories that we mention is not exact, but it uses more popular terms, it simplifies the exposition and captures the intuition behind the original categories.

attract private funding of university research, so public funding will not be so necessary and hence taxpayers will benefit. Second, governments also expect that UIR will orient what faculty know and report to their alumni about firms' needs[5]. On the other hand, notice, that, unlike Lee (1996), we did not include consultancy and patents as objectives since we consider them instruments of cooperation.

Our next dependent variable is:

- Cooperation: perceived degree of R&D cooperation with firms. We considered three answers, ranked as follows: 0 ("none"), 1 ("some") and 2 ("much" or "very much").

Given the qualitative and indexed nature of the response variables we decided to use an ordered probit for estimating our econometric models.

We are going to estimate seven models, six for the support for each objective of UIR and one for R&D cooperation. Here are the list and description of the explanatory variables:

- University: university of the professor: *univ1*, the oldest university (five hundred years old); *univ2*, a younger one (forty years old) and *univ3*, a group of the three youngest universities (created during the last twenty-five years) –see section 3 for details. The last one will be the benchmark. These dummies represent age and, according to our previous considerations, different scientific prestige and culture.
- Personal: a vector of four variables reflecting the following personal characteristics:
  - Seniority: 1 if the professor is older than forty years, his/her teaching experience has lasted at least ten years, his/her teaching scale is the highest (full professor) and he/she has received at least one Spanish six-year term research award (so-called sexenium).
  - Gender: 1 if the respondent is a man and 0 if she is a woman.
  - Management: 1 if the respondent holds a managerial position within the university and 0 otherwise.
  - Abroad: length of research abroad. We considered five blocks, ranging from 0 (the shortest) to 4 (the longest).
- Disciplines: in order to make comparison with Lee's work easier, we considered the same three groups: *ens* (exact and natural sciences), *et* (engineering and technology) and *ssh* (social sciences and humanities). This last one acts as benchmark.

[5] Martin and Etzkowitz (2000) provide some arguments to support these objectives, e. g. "there is no convincing evidence that an emphasis on helping the needs of society and the economy results in adverse long-term consequences for university teaching and research", "the autonomy of the university may actually be strengthened as it becomes less dependent on government funding".

- RDt: proportion of time devoted to R&D activities. We also requested time dedicated to teaching, other educational activities (e.g. training, lifelong learning, etc.), management and other activities, so that the total had to sum one.
- Encouragement: perceived influence of the institutional policy of the respondent's university on cooperation with firms. Following Lee, we it is equal to 1 if faculty answer, "it favours cooperation", 0 otherwise.
- Incentives: influence of UIR on the following aspects, with three possible answers: 1 ("negative"), 2 ("none") and 3 ("positive"):
  - Wage: professor's salary.
  - Openings: professional openings for students and collaborators.
  - Knowledge: exchange of relevant knowledge.
  - Public: public resources for R&D projects.
  - Career: scientific career (sexenia).
- Fear: influence of UIR on the following aspects of academic life, with three possible answers: -3 ("negative"), -2 ("none") and -1 ("positive"):
  - Freedom: freedom of selection of research agenda.
- Instruments: preferred activities for interacting with firms, each one taking value 1 if the respondent chose the activity and 0 otherwise[6]. The full list appears in the next section. Here we give the names of the groups of variables that we constructed:
  - Morebid: more preferred bidirectional instruments.
  - Moreuni: more preferred unidirectional instruments.
  - Lessbid: less preferred bidirectional instruments.
  - Lessuni: less preferred unidirectional instruments. This is the benchmark.

4.2. Descriptive analysis of the data

Table 5 offers a perspective on the data through the descriptive statistics of the variables, discarding "don't knows". We weighted the answers according to the stratification variable (teaching scale –full professors, assistant professors and associate professors).

The average values in Panel A allow us to observe that the most supported objectives are, as in Lee's study, orientation, development and commercialisation, plus a new one, funds. The least supported ones are creation of

firms, as in Lee's sample, plus a new one, adaptation of teaching. Therefore, there are similarities between the Valencian case and the US case.

Concerning our measure of R&D cooperation, most respondents perceive that they have a zero degree of cooperation. In terms of the frequency distribution of the variable, they are 45%, while 35% perform some cooperation and 20% perform much or very much cooperation.

Panel B includes independent variables. We may notice that university 1 is the largest (31% of total faculty), as a reflection of being the oldest one in the sample. University 2 follows (28%) and the three younger universities we keep as a benchmark have the rest of the observations (41%).

With regard to personal characteristics, 22% of respondents fit our definition of senior professors. Male gender predominates (72%). 16% have a managerial position. The average length of research abroad is between our categories 1 (0-5 months) and 2 (6-11 months).

By scientific discipline, the distribution of the three groups is quite homogenous: exact and natural sciences (35%), engineering and technology (33%) and social sciences and humanities (32%, the benchmark).

The time dedicated to R&D activities is, on average, 30% of total academic time. The rest is dedicated to teaching, other educational activities (e.g. training, lifelong learning, etc.), management and other activities.

Most respondents think that the policy of their university favours UIR (54%) and the rest have other opinions (46%)[7]. Within this benchmark "don't knows" abound (25%), so it reflects (a remarkable) ignorance of the situation.[8]

Regarding incentives, the perception is that UIR is more positive for professional openings (average 2.85) (a contrast with the finding that the adaptation of teaching is the least supported objective of UIR), acquisition of public funds (average 2.80) and knowledge exchange (average 2.76). UIR would be less positive for wage and career incentives (averages 2.51 and 2.24 respectively). The fear of loss of freedom does not seem very important, compared to incentives (average in absolute terms 2.08).

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[6] Respondents could choose up to three activities.

[7] We may wonder whether the perceived encouragement correlates with the university of the respondent. This is not the case, since the coefficients of correlation between the variable *encouragement* and the variables *univ1* and *univ2* are only -0.19 and 0.17 respectively.

[8] We chose to include the "don't knows" category in the third dummy variable because the considerable proportion of answers of this type to this question (25%) made us think that ignorance of the performance of the university could be relevant as a reference. In turn, the proportion of answers of the type "it does not harm cooperation" or "it damages cooperation" is not so high (13% and 6% respectively).

The more preferred bidirectional instruments of cooperation are collaborative research and practices for students in firms (average 0.57 and 0.38 respectively). The more preferred unidirectional instruments are consultancy and contract research (average 0.55 and 0.53 respectively). Less preferred are some bidirectional instruments: joint centres, exchange of scientists and informal contacts (average 0.22, 0.18 and 0.10 respectively). So are some unidirectional instruments: seminars for firms and patent licensing (average 0.21 and 0.05 respectively). Compared to Meyer-Krahmer and Schmoch's (1998) finding of the preference for bidirectional flows in the German case, we find a high value of collaborative research and knowledge exchange, but also a high value of contract research and consultancy and a low value of informal contacts, showing a certain tension between the two types of flows. We may interpret this as an idiosyncrasy of a region with low absorptive capacity.

5. Results

After eliminating "don't knows", we had slightly more than 200 observations per dependent variable for the estimations. The specific number depends on the "don't knows" of each dependent variable and the deleted independent variables. We directly show reduced models in Table 6[9] and marginal effects in Table 7.

5.1. Support for the objectives of UIR: validation of national (US) determinants

The results regarding support for the objectives of UIR appear in Columns 1 to 5 of both tables. Notice that the objective "creation of firms" is missing because we could not estimate a significant model to explain it.[10] The following comments apply to the support for the rest of the objectives.

Belonging to an older university negatively influences the support for the objectives of UIR. This influence is significant in the case of medium-supported objectives (development, funds and commercialisation[11]) but, in any case, it is similar to Lee's result. Furthermore, marginal effects show that a unit decrease of *univ1* and *univ2* increases the probability of "some support" and "no/weak support". For instance, a unit decrease of *univ1*

[9] We compare the Bayesian Information Criterion (BIC) to reduce the models. BIC tends to penalise the entrance of new observations. Hence, final reduced models admit some non-significant variables that, if deleted, incorporate a large number of "don't knows".

[10] Exploratory evidence indicates that, if we exclude faculty who devote 0% of their time to R&D activities (around 10% of total faculty), the share of industrial funding of R&D makes the model significant. It suggests that the creation of firms achieves support when it is difficult to obtain industrial funds by other means.

increases the probability of "some support" for *development* by 10.4% and the probability of "no/weak support" by 14.9%. Hence, we find support for H1.

The disciplinary effect is not significant for differentiating the importance granted to the objectives of UIR. This constitutes a difference with Lee's work, which found the area of engineering and technology (what he denominated "applied sciences") the most inclined to support them. Therefore, we do not find support for H2.

Time devoted to R&D activities (*RDt*) is not significant for any of the objectives. Although our measure of dedication to R&D is different to Lee's, this lack of significance is coincident. It means evidence against H3.

The perception that the university encourages cooperation does not have a significant effect on support for the objectives of UIR either[12]. This constitutes another difference from Lee's sample, where university encouragement was significant. Hence, we do not find support for H4. In addition, this finding fits with our experience as former managers of a TTO[13], when we found that the direct measures that universities use to encourage UIR are not effective if not accompanied by other more subtle actions, addressed to produce cultural changes. Our university dummies (not included by Lee in his econometric estimations) may capture such changes.

The fear that UIR might interfere with academic freedom influences the support for its objectives, significantly for some of the most valued objectives (orientation, development) and for the least valued one (teaching). According to marginal effects, a unit decrease of *fear* increases the probability of "some support" and "no/weak support" in general. Thus, we agree with Lee, with the minor remark that the effect is not significant for the rest of the objectives. Overall, we find support for H5, at least concerning academic freedom.

To sum up, we find coincidences between Lee's US sample and our own Valencian Community sample in the negative effects of university age (and hence scientific prestige and culture), and fear of loss of academic freedom, on support for the objectives of UIR, as well as in the non-significant effect of dedication to R&D. However, we find some idiosyncrasies of our sample regarding the non-significant effects of university encouragement and disciplines.

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[11] For the latter objective, it is the only significant explanatory variable.

[12] The exception is the significantly negative effect of university encouragement on the objective of "adaptation of teaching". It raises the existence of a conflict of commitment between faculty and their institution. Campbell and Slaughter (1999) find a somewhat similar result in the US case: "conflict of commitment was the only scale on which faculty and administrators' views were significantly different" (p. 317).

[13] Two of the authors, Ignacio Fernández-de-Lucio and Antonio Gutiérrez-Gracia, were former heads of the TTO of one of the universities in the sample.

5.2. Support for the objectives of UIR: further determinants

The new variables used to extend Lee's model allow us to derive additional results, still in columns 1 to 5. To begin with, none of the personal characteristics considered (seniority, gender, managerial position and length of research abroad) turns out to be significant.[14] That is to say, we find evidence against H6.

The perception of the influence of UIR on incentives generally exerts little effect on support for the objectives of UIR. The extreme cases are the possibilities of improving wages or career prospects, which are not significant at all. However, the effects of the rest of the incentives on some specific objectives are relevant and varied in sign:

- Professional openings are significant in increasing support for the objective of adaptation of teaching. Marginal effects show that a unit increase in *openings* increases the probability of "some support" for *teaching* by 5.3% and the probability of "no/weak support" by 13.5%. Given that this objective has more negative forces than the rest determining its support (e.g. seniority and university encouragement), improvement of professional openings through UIR seems an obvious policy measure to overcome them.
- Knowledge exchange has a significant negative sign in the case of participation in the economic development of the region. Moreover, marginal effects show that a unit decrease in *knowledge* increases the probability of "some support" for *development* by 9.8% and the probability of "no/weak support" by 9.7%. We suggest that the explanation lies in the fact that if firms in the region have low absorptive capacity, faculty who cooperate with them will exchange less relevant knowledge than if they resort to firms outside the region. This is the case of the Valencian Community (Fernandez et al., 2001).
- Public funds have a significant positive effect on support for the objective of obtaining additional funds. Similarly, marginal effects show that a unit decrease in *public* decreases the probability of "some support" for *funds* by 12.7% and the probability of "no/weak support" by 12.8%. This indicates that these additional funds are not necessarily financed by firms. This may challenge the usual view of policy makers that UIR helps to reduce the taxpayers' burden through substitution of public funding by private funding.

Regarding H7, we do not find evidence to support it in general, and for specific cases, we find evidence either in favour (influence of openings on teaching, of public funds on additional funds) or against it (influence of knowledge on regional development).

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[14] The only exception is a lower support from senior professors for the adaptation of teaching. Moreover, marginal effects show that a unit increase in *seniority* decreases the probability of "some support" for *teaching* by 5.9% and the probability of "strong support" by 11.4%.

Finally, instruments of cooperation are jointly significant for only two of the most supported objectives (orientation and development). Furthermore, a unit decrease in *morebid (moreuni*) decreases the probability of "some support" for *development* by 8.1% (13%) and the probability of "no/weak support" also by 8.1% (12.8%,). However, marginal effects for *moreuni* are ambiguous regarding *orientation*. This means that support for H8 is partial. It seems that, in every case, a necessary (but not sufficient) condition for existing instruments to have a significant influence is that their objectives must be widely supported.

For these objectives (orientation and development), the highest significance is for the most preferred unidirectional instruments (consultancy plus contract research). More preferred bidirectional instruments (collaborative research plus student practices) are not significant for orientation and they are less significant for development than less preferred bidirectional instruments (joint centres plus scientist exchange plus informal contacts). This means that we also find only partial support for H8a. Hence, policy makers should be aware of the significance of less popular instruments to get some support for UIR.

The findings also provide partial support for H8b. This challenges the importance given by Meyer-Krahmer and Schmoch (1998) to bidirectional flows in UIR. Either they are not enough to generate support for the objectives, or this is a feature of regions with low absorptive capacity. In such regions, it is easier for faculty to transfer existing knowledge than to engage in interactive generation of new knowledge.

5.3. R&D cooperation with firms

The estimation results are in columns 6 of Table 6 and Table 7. To start with, we can observe that the respondent's university does not have a significant impact on support for this objective of UIR, even though it does influence most others.

On the other hand, most personal characteristics do not have an influence on R&D cooperation, or on the objectives of UIR. However, there is a highly significant gender effect, favouring males. Moreover, marginal effects show that a unit increase in *gender* increases the probability of "some" *cooperation* by 8.9% and the probability of "much/very much" by 13.7%. It may indicate that the integration of females into UIR is low, in consonance with their lack of integration in the Spanish academic world in terms of scientific productivity (García-Romero and Modrego, 2001), perhaps because of their focus on teaching.

The disciplinary dummy has a significant positive sign in engineering and technology. Moreover, marginal effects show that a unit increase in *Et* increases the probability of "some" *cooperation* by 1.8% and the probability of "much/very much" by 35.4%. As explained above, for the *support* variables we expected this

positive effect, but we did not find it. Hence, all disciplines give the same support for the objectives of UIR regardless significant differences on how often they cooperate. Our experience as former managers of a TTO confirms this divorce between purpose and actual action, from two points of view: first, the characteristics of the region do not give faculty in social sciences and humanities many opportunities to cooperate, but they still support UIR to join a general state of opinion; second, faculty in engineering and technology cooperate more, but the difficulties to do so diminish their support for UIR.

Time devoted to R&D influences cooperation positively. Marginal effects show that a unit increase in *RDt* increases the probability of "some" *cooperation* by 18.8% and the probability of "much/very much" by 55.5%. This is another difference from the support for the objectives of UIR, in which this variable does not matter.

Similarly, institutional encouragement fosters R&D cooperation while it was insignificant in the support for its objectives. In this case, marginal effects show that a unit increase in *encouragement* increases the probability of "some" *cooperation* by 5.2% and the probability of "much/very much" by 13.5%.

Some incentives have a significant negative effect on cooperation: wage, career and public funds. Marginal effects show that a unit increase in *wage* (*career* and *public funds*) decreases the probability of "some" *cooperation* by 3.5% (4.3% and 2.6%, respectively) and the probability of "much/very much" by 10.4% (12.6% and 7.8%, respectively). That is to say, the more positive the perceived influence of UIR on these incentives, the lower R&D cooperation will be. In other words, faculty who believe that cooperation is going to enhance these incentives are not those who actually cooperate more. In the case of wage and career, since the expected effects of UIR on them are not remarkable (see section 4.2), the result is logical. In the case of public funds, the explanation may lie in the existence of sources other than R&D cooperation.

Let us recall the positive effect of public funds on the support for the objective of getting additional funds. Hence, we find that the (highly valued) incentive of obtaining public funds enhances this support but not R&D cooperation. This suggests that although researchers perceive a favourable policy towards innovation (see section 3), granting public funds for UIR does not require subsequent proof of R&D cooperation taking place.

In turn, there are no incentives with significant positive effects. This means that either we did not include the relevant incentives in the questionnaire or that cooperation is not positively incentive-driven.

Fear of loss of freedom has a significant negative impact on the degree of cooperation, whereas instruments are not jointly significant in their impact. Both effects are similar to the case of support for most objectives. In the case of *fear*, marginal effects show that a unit increase in *fear* decreases the probability of "some" *cooperation* by 2.4% and the probability of "much/very much" by 7.1%.

We are now able to position ourselves concerning H9. We do not find support for it in the sense that support for the objectives of UIR depends on the type of university while the degree of R&D cooperation depends on discipline, devotion to R&D and university encouragement. However, we do find support for H9 in the sense that neither support for the objectives nor R&D cooperation depend on either personal characteristics (except for the effect of gender on cooperation) or instruments, but both depend (negatively) on fear. The evidence about incentives is not conclusive.

6. Conclusions and future research lines

Although there are many similarities in terms of the objectives of UIR in the Valencian region and in technology leading countries, the determinants of the attitudes towards UIR are clearly differing. We have found that disciplinary effects and university encouragement are not significant in the Valencian Community. The comparison is not straightforward since a nation and a region are different units of observation. Rather, the results emphasise that what is valid for the former might not be for the latter. The explanation may lie in the heterogeneous absorptive capacity or regions within a country.

It is important to understand the role that incentives and instruments play in the generation of support for the objectives of UIR. Incentives are not significant in general, but some produce specific effects that should be taken into account, if we trust the perception of faculty members. Enhancing professional openings for students and collaborators increases support for the least-supported objective, the adaptation of teaching. Two other incentives generate dynamics that policymakers do not always predict. First, knowledge exchange does not contribute to regional development in a region with low absorptive capacity. Second, public funds are the additional funds that UIR helps to obtain, not private investment that would reduce the load on the public budget. Besides, these public funds do not lead to R&D cooperation.

On the other hand, existing instruments become opportunities for faculty to reach some of the most supported objectives, but not every objective. Therefore, although important, their scope is quite limited. Nor do we find that bidirectionality in the flows of knowledge is a significant component in the nature of the instrument, maybe an idiosyncratic feature of a region with low absorptive capacity. The same is true for R&D cooperation.

We have provided some evidence that support for the objectives of UIR is different from R&D cooperation. The former is sensitive to university influence (not through direct encouragement but through different scientific prestige and cultural roots). The latter is sensitive to gender, discipline, devotion to R&D and university direct encouragement. Therefore, policies to foster each one may differ. We are especially concerned with our finding

on disciplines, which seem to have no significant effect on support, as against a higher propensity to cooperate in engineering and technology. This may reflect either fewer opportunities to engage into UIR in other disciplines or the existence of a certain snobbishness in a region with low absorptive capacity.

One limitation of the paper is that the econometric models should be complemented with interviews with key informants on university management as well as with those faculty most engaged and most opposed to UIR. We do not discard them for the future. A second limitation is that it would be convenient to compare our sample with evidence from a region with high absorptive capacity, rather than from a country. However, we note that in a region of low absorptive capacity, faculty support for UIR differs from that found in a whole country with a different level of technological development. By exploring some of the reasons that can explain such differences, we point to future research avenues.

These should focus on explaining the objective of creation of firms, finding specific university policies that produce a significant effect of university encouragement on R&D cooperation, disentangling why females show less propensity to cooperate in R&D and whether public funds for UIR are not effective. We have also set the basis for a theoretical development that aims to establish the equilibrium between support for university-industry relations and degree of R&D cooperation.

Acknowledgements

The High Consultant Council on R&D of the *Generalitat Valenciana* provided the main funds for this study, at the initiative of Manuel López Estornell. We are obliged to our colleagues for their help in gathering the data of the survey (Carlos Dema, Gregory Dufour, Ronald Huanca, Fernando Jiménez, Susana Pérez, Eugenio Portela, Marisa Rodríguez, Pedro Serra and Enrique Tortajada), and to Luis Izquierdo, for the preparation of the database. We thank Anita McGahan and Finn Valentin for helpful comments on a previous version at the Druid Summer Conference 2003. Not less than Jordi Molas-Gallart and Aldo Geuna, who provided invaluable encouragement to publish the outcome of the research.

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Tables

Table 1 R&D and human capital in the Valencian Community

Year 2003	Valencian Community	Spain	European Union (15)
Gross Domestic Expenditure on R&D (GERD) as a percentage of GDP	0.87	1.10	1.98
Business expenditures on R&D	*0.30*	*0.60*	*1.30*
Public R&D expenditures	*0.57*	*0.50*	*0.68*
R&D personnel (FTE/1000 inhabitants)	3.04	3.55	4.99
Business enterprise sector	*1.05*	*1.53*	*2.78*
Public sector	*2.00*	*2.02*	*2.21*
Researchers (FTE) per 1000 inhabitants	1.86	2.16	2.81
Business enterprise sector	*0.44*	*0.65*	*1.46*
Public sector	*1.42*	*1.51*	*1.35*
Human capital			
Population with tertiary education (% of 25 - 64 years age class)	*19.9*	*22.7*	*22.0*
Population with tertiary education (% of active population) (2004)	*26.1*	*29.8*	*n.a.*
Population with tertiary education (% of total employment) (2004)	*26.8*	*30.7*	*n.a.*

Sources: INE (2005c, d), Eurostat (2004), EC (2003)

Table 2 Universities in the Valencian Community

Year 2002	Year of creation	Number of students	Number of professors	Main discipline	Budget (%GDP)
University of Alicante	1979	28,250	1,524	Social sciences (54%)	0.19%
University Jaume I of Castellon	1991	13,359	768	Social sciences (56%)	0.13%
University Miguel Hernandez	1997	9,091	623	Technology and health sciences (62%)	0.11%
Polytechnic University of Valencia	1971	34,299	2,225	Technology (85%)	0.35%
University of Valencia	1500	46,989	2,991	Social sciences (56%)	0.41%
Total Valencian Community		131,988	8,131	Social sciences (40%)	1.19%
Total Spain		1,286,483	74,185	Social sciences (46%)	0.91%

Source: CRUE (2004) and own elaboration

Table 3 Universities' Technology Transfer Offices in the Valencian Community

Year 2002	Year of creation of TTO	TTO budget (% university budget)	Value of contractual funds (% university budget)	Value of granted funds (% university budget)
University of Alicante	1989	n.a.	1.94%	3.35%
University Jaume I of Castellon	1996	0.33% (*)	1.10%	5.38%
University Miguel Hernandez	1997	0.56% (*)	2.57%	8.41%
Polytechnic University of Valencia	1989	0.47% (*)	6.31%	6.79%
University of Valencia	1989	0.14%	3.47%	13.11%
Total Valencian Community		0.33%	3.74%	8.43%
Total Spain		0.11%	3.24%	7.34%

Source: CRUE (2004) and own elaboration
(*) These offices are also in charge for management of granted funds

Table 4 Change in faculty attitudes over time in the Valencian Community

Do you think that universities should engage into R&D activities for industry? (n=380)	Today	Five years ago	Percentage difference
Yes	94%	86%	9%
Indifferent	2%	8%	-7%
No	3%	5%	-1%
Don't know	1%	2%	-1%

Table 5 Descriptive statistics of the sample

A) Dependent variables

Variable	Sub variable	Mean	Std. Dev.	Minimum	Maximum	Observations
Objectives	Orientation	1.52	0.65	0	2	371
	Development	1.37	0.71	0	2	369
	Funds	1.37	0.71	0	2	368
	Commercialisation	1.16	0.76	0	2	366
	Firms	0.97	0.82	0	2	367
	Teaching	0.83	0.78	0	2	371
Cooperation		0.75	0.77	0	2	373

B) Independent variables

Variable	Sub variable	Mean	Std. Dev.	Minimum	Maximum	Observations	Ranking MK&S (1998)[♣]
University	Univ1	0.31	0.46	0	1	380	
	Univ2	0.28	0.45	0	1	380	
Personal	Seniority	0.22	0.41	0	1	361	
	Gender	0.72	0.45	0	1	380	
	Direction	0.16	0.36	0	1	376	
	Abroad	1.29	1.38	0	4	373	
Discipline	Ens	0.35	0.48	0	1	376	
	Et	0.33	0.47	0	1	376	
RDt		0.30	0.19	0	0.9	376	
Encouragement		0.54	0.50	0	1	378	
Incentives	Wage	2.51	0.61	1	3	310	
	Openings	2.85	0.46	1	3	362	
	Knowledge	2.76	0.53	1	3	354	
	Public	2.80	0.50	1	3	342	
	Career	2.24	0.72	1	3	297	
Fear	Freedom	-2.08	0.81	-3	-1	304	
Instruments	Morebid	0.95	0.61	0	2	358	
	Collaborative research	0.57	0.50	0	1	358	1
	Practices for students in firms	0.38	0.49	0	1	358	-
	Moreuni	1.08	0.66	0	2	358	
	Consultancy	0.55	0.50	0	1	358	3
	Contract research	0.53	0.50	0	1	358	3
	Lessbid	0.49	0.59	0	2	358	
	Joint centres	0.22	0.42	0	1	358	-
	Scientist exchange	0.18	0.38	0	1	358	4
	Informal contacts	0.10	0.30	0	1	358	2
	Lessuni	0.27	0.44	0	1	358	
	Seminars for firms	0.21	0.41	0	1	358	4
	Patent licensing	0.05	0.23	0	1	358	-

[♣] MK&S stands for “Meyer-Krahmer and Schmoch”. The ranking applies to instruments only. 1 is the most relevant, 5 is the less relevant. The authors did not include practices of students, patent licenses nor creation of joint centres. On the other hand, they included education of personnel, doctoral theses, conferences, publications and committees, all of them ranking from 3 to 5.

Table 6 Ordered probit estimation of the support to the objectives of university-industry relations and R&D cooperation – reduced models

Variable	Sub-variable	1 Orientation	2 Development	3 Funds	4 Commercialisation	5 Teaching	6 Cooperation
Constant		0.21 (0.6)	0.52 (0.65)	0.22 (0.66)	0.8 (0.43)	-2.44 (0.7) **	0.92 (0.6)
University	Univ1	-0.45 (0.21) *	-0.65 (0.21) **	-0.67 (0.21) **	-0.71 (0.2) **		
	Univ2	-0.29 (0.21)	-0.36 (0.21)	-0.64 (0.21) **	-0.51 (0.19) **		
Personal	Seniority	-0.12 (0.2)		0.25 (0.21)	0.03 (0.19)	-0.44 (0.2) *	0.26 (0.2)
	Gender						0.6 (0.22) **
	Management						
	Abroad		-0.01 (0.06)	-0.09 (0.07)			
Discipline	Ens						0.21 (0.23)
	Et						1.19 (0.23) **
RDt							2.09 (0.55) **
Encouragement						-0.34 (0.17) *	0.52 (0.18) **
Incentives	Wage	-0.1 (0.15)	-0.03 (0.14)	-0.04 (0.15)	-0.09 (0.13)	0.07 (0.14)	-0.39 (0.15) **
	Openings			-0.36 (0.21)		0.48 (0.21) *	
	Knowledge		-0.49 (0.18) **				
	Public			0.64 (0.2) **			-0.48 (0.18) *
	Career	0.08 (0.13)	0.21 (0.13)	0.23 (0.13)	0.17 (0.12)	0.2 (0.13)	-0.29 (0.14) *
Fear	Freedom	-0.29 (0.12) *	-0.24 (0.11) *	-0.11 (0.11)	-0.08 (0.11)	-0.44 (0.11) **	-0.27 (0.12) *
Instruments	Morebid	0.18 (0.17)	0.41 (0.17) *				
	Moreuni	0.48 (0.18) **	0.65 (0.18) **				
	Lessbid	0.35 (0.18)	0.59 (0.19) **				
μ_1		1.11 (0.13) **	1.22 (0.12) **	1.28 (0.13) **	1.12 (0.1) **	0.97 (0.1) **	1.38 (0.13) **
Number of observations		214	215	200	212	208	204
Log-likelihood function		-178.80	-194.31	-182.52	-219.33	-200.56	-180.24
Restricted log-likelihood		-191.30	-212.67	-200.26	-226.64	-220.80	-219.71
χ^2-test		24.99**	36.73**	35.47**	14.61*	40.49**	78.94**
Degrees of freedom		9	10	9	6	6	10

* Significant at 5%. ** Significant at 1%.

Table 7 Marginal effects on Prob[y=0,1 or 2] at means for ordered probit model: Regressions of Equations 1-6.

Variable	Sub-variable	1 Orientation			2 Development			3 Funds			4 Commercialisation			5 Teaching			6 Cooperation		
		= 0	= 1	= 2	= 0	= 1	= 2	= 0	= 1	= 2	= 0	= 1	= 2	= 0	= 1	= 2	= 0	=1	= 2
Constant		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
University	Univ1	0.080	0.095	-0.174	0.149	0.104	-0.253	0.155	0.103	-0.258	0.230	0.014	-0.244						
	Univ2	0.049	0.063	-0.112	0.078	0.066	-0.143	0.145	0.100	-0.245	0.163	0.019	-0.182						
Personal	Seniority	0.020	0.028	-0.048				-0.047	-0.053	0.101	-0.010	-0.002	0.012	0.172	-0.059	-0.114	-0.090	0.018	0.072
	Gender																-0.226	0.089	0.137
	Management																		
	Abroad				0.001	0.001	-0.003	0.017	0.017	-0.034									
Discipline	Ens																-0.074	0.017	0.057
	Et																-0.372	0.018	0.354
RDt																	-0.742	0.188	0.555
Encouragement														0.134	-0.036	-0.098	-0.186	0.052	0.135
Incentives	Wage	0.016	0.023	-0.040	0.005	0.005	-0.011	0.008	0.008	-0.016	0.026	0.006	-0.032	-0.026	0.008	0.019	0.139	-0.035	-0.104
	Openings							0.072	0.071	-0.142				-0.188	0.053	0.135			
	Knowledge				0.097	0.098	-0.196												
	Public							-0.128	-0.127	0.255							0.169	-0.043	-0.126
	Career	-0.013	-0.019	0.032	-0.043	-0.043	0.085	-0.047	-0.046	0.093	-0.052	-0.012	0.064	-0.080	0.023	0.058	0.104	-0.026	-0.078
Fear	Freedom	0.046	0.065	-0.111	0.048	0.048	-0.096	0.022	0.022	-0.044	0.023	0.005	-0.029	0.173	-0.049	-0.124	0.095	-0.024	-0.071
Instruments	Morebid	-0.028	-0.040	0.068	-0.081	-0.081	0.162												
	Moreuni	-0.076	-0.109	0.184	-0.128	-0.130	0.258												
	Lessbid	-0.056	-0.080	0.136	-0.116	-0.117	0.234												